

History of the Hydrologic Frequency Analysis Workgroup and Previous Flood Frequency Workgroups

Introduction

This document provides a brief history of flood frequency workgroups that have existed since the publication of Bulletin 17B, *Guidelines For Determining Flood Flow Frequency*, by the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data in March 1982. The scope and accomplishments of each workgroup are highlighted. The activities of the current flood frequency workgroup, the Hydrologic Frequency Analysis Workgroup (HFAWG), are briefly described.

Bulletin 17B Recommendations

Bulletin 17B identified a list of related topics (not ranked by priority) that needed future research and these topics are as follows:

1. Selection of distribution and fitting procedures.
2. The identification and treatment of mixed distributions.
3. The treatment of outliers both as to identification and computational procedures.
4. Alternative procedures for treating historic data.
5. More adequate computation procedures for confidence limits to the Pearson Type III distribution.
6. Procedures to incorporate flood estimates from precipitation into frequency analysis.
7. Guides for defining flood potentials for ungaged watersheds and watersheds with limited gaging records.
8. Guides for defining flood potentials for watersheds altered by urbanization and by reservoirs.

The Bulletin 17B Workgroup did not have the time or resources to pursue the above topics but felt they were important in improving flood frequency guidelines for both gaged and ungaged watersheds.

December 1987 Report of an Ad Hoc Workgroup

In February 1985, the Hydrology Subcommittee of the Interagency Advisory Committee on Water Data sent out a questionnaire to Federal agencies asking if there was a need to revise or refine Bulletin 17B. Responses were received from 118 individuals most of whom had more than 10 years of experience.

An Ad Hoc Workgroup of the Hydrology Subcommittee consisting of the U.S. Army Corps of Engineers (USACE), Environmental Protection Agency (EPA), Federal Emergency Management Agency (FEMA), Soil Conservation Service (SCS), National Weather Service (NWS), Tennessee Valley Authority (TVA), U.S. Geological Survey (USGS), and Bureau of Reclamation (BOR) summarized the results of the questionnaire in a December 1987 report. The conclusions from the questionnaire were:

- Bulletin 17B should not be revised at this time because the users have not identified substantial problems or new techniques that could be included in a revised Bulletin 17B,
- The present workgroup should be abolished,
- A new workgroup should be formed to develop a series of pamphlets that would supplement Bulletin 17B,
- The report summarizing the questionnaire should be circulated to the Hydrology Subcommittee members for their information but not published for public dissemination.

The general conclusion was that Bulletin 17B guidelines prescribe technically sound procedures, that no substantial problems within the scope of the guidelines have been identified that cannot be handled by means included in the guidelines, and that no breakthroughs in statistical practice have occurred to provide feasible, substantial, and clearly superior technical alternatives to the Bulletin 17B methodology.

The Bulletin 17B skew map was cited as the most important problem. However, the Ad Hoc Workgroup concluded that the skew map is optional and other regional skew values may be used, and therefore, the skew map does not materially detract from the usefulness of Bulletin 17B.

In the December 1987 report, the Ad Hoc Workgroup recommended that “a series of pamphlets be issued by the Hydrology Subcommittee to provide guidance for solving common major flood frequency analysis problems identified in the survey.” A new workgroup should be formed to prepare the pamphlets. The top five topics recommended for the pamphlets were as follows:

- Regional skew,
- Detection and treatment of outliers,
- Mixed population analysis,
- Multi-station comparison,
- Watershed changes and time trends.

Other topics suggested by the Ad Hoc Workgroup included:

- Partial duration analysis,
- Typical examples of using Bulletin 17B,
- Diagnostics and interpretation of analysis,
- Coincident frequency analysis.

Bulletin 17B Workgroup (1989-99)

In August 1989, a new Bulletin 17B Workgroup was formed consisting of the following Federal agencies: FEMA, TVA, NWS, SCS, USACE, and USGS. This workgroup selected the following four topics for pamphlets to supplement Bulletin 17B:

- Watersheds undergoing changes and time trends,

- Regional skew,
- Detection and treatment of outliers,
- Regulated watersheds.

Three of the four selected topics were consistent with the December 1987 report of the Ad Hoc Workgroup. The fourth topic of regulated watersheds was added because of the perceived need for more consistent guidance. The following work was completed toward publishing pamphlets on the above topics.

Watersheds undergoing changes and time trends

A report entitled *Evaluating the Effects of Watershed Changes on the Flood Frequency Curve* was prepared by the workgroup and reviewed by the Subcommittee on Hydrology in April-May 1991 and again in January-February 1994. The report was never forwarded to the Interagency Advisory Committee on Water Data for approval because the Bulletin 17B Workgroup could not reach a consensus on the value of this pamphlet. With permission of the Bulletin 17B Workgroup, Rick McCuen, University of Maryland, published a textbook in 2003 entitled *Modeling Hydrologic Change – Statistical Methods* that included the workgroup report plus several additional topics.

Regional Skew

The workgroup summarized the status of several generalized skew studies. In May 1990, the Wisconsin District of USGS sent the workgroup a proposal for *Developing Regional Skewness for the United States*. The study was proposed for a 3-year period with a total funding level of \$110,000. At that time (1990), the Federal agencies on the workgroup could not identify the needed funding and the study was never undertaken.

Detection and treatment of outliers

The workgroup funded a small study by Rick McCuen, University of Maryland, to perform research on detection and treatment of outliers. As part of this contract, a report entitled *Detection of Outliers in Pearson Type III Distributions* was prepared by Colleen Spencer (graduate student) and Rick McCuen that provided a new method for detecting outliers in a frequency analysis. The consensus of the workgroup was that the new method was not a significant improvement over the existing method in Bulletin 17B and therefore no changes in outlier detection were adopted. Colleen Spencer and Rick McCuen published the paper entitled *Detection of Outliers in Pearson Type III Data* in the ASCE Journal of Hydrologic Engineering in 1996 (Vol.1, pages 2-10).

Regulated Watersheds

Harold Kubik, USACE, prepared an outline of a report on regulated watersheds. With Harold's untimely death in January 1991, the work on this report came to a halt.

Other activities

The workgroup also funded a small study by Rich Vogel, Tufts University, in 1990-91 to study goodness-of-fit tests for determining if flood data fit the Pearson Type III frequency distribution. The culmination of this work was a paper entitled *Probability Plot Goodness-of-Fit and Skewness Estimation Procedures for the Pearson Type 3 Distribution* that was published by Vogel and McMartin in the December 1991 issue of *Water Resources Research* (Vol. 27, No. 12, pages 3149-3158).

Hydrologic Frequency Analysis Workgroup (2000 - present)

The Terms of Reference of a new Hydrologic Frequency Analysis Workgroup (HFAWG) were signed by the Subcommittee on Hydrology of the Advisory Committee on Water Information in December 1999. Unlike the previous workgroups, the new workgroup consists of Federal and non-Federal participants. In January 2000, the HFAWG had their first meeting and undertook the following tasks as assigned by the Subcommittee on Hydrology:

- Develop a position paper on flood frequency analysis for ungaged watersheds,
- Develop a set of Frequently Asked Questions and Answers on Bulletin 17B,
- Develop guidance on flood frequency analysis for watersheds whose flood flows are regulated by upstream flood detention structures.

Status of the Original Charge to the HFAWG

A paper entitled *Evaluation of Flood Frequency Estimates for Ungaged Watersheds* was completed in August 2001 and posted on the HFAWG web site in October 2002 (<http://acwi.gov/hydrology/Frequency>). This paper describes an approach for evaluating flood discharges estimated from regression equations and rainfall-runoff models and for judging the reasonableness of the flood discharges using a measure of uncertainty such as the standard error. Regional regression equations and rainfall-runoff models are the two most frequently-used approaches for estimating the magnitude and frequency of flood discharges for ungaged watersheds.

A list of *Frequently Asked Questions and Answers on Bulletin 17B* was prepared by the HFAWG and posted on their web site on September 29, 2005. The questions and answers provide additional guidance and clarification on procedures and terminology given in Bulletin 17B.

An outline of a report describing various approaches for frequency analyses for regulated watersheds has been prepared but the report has not been completed. This is still an outstanding task for the HFAWG to complete.

Plans to Update Bulletin 17B

In November 2005 the HFAWG developed a plan for updating Bulletin 17B. The major improvements in Bulletin 17B that will be evaluated include:

- Evaluate and compare the performance of the Expected Moments Algorithm (EMA) to the weighted-moments approach of Bulletin 17B for analyzing data sets with historical information.
- Evaluate and compare the performance of EMA to the conditional probability adjustment of Bulletin 17B for analyzing data sets with low outliers and zero flows,
- Described improved procedures for estimating generalized (regional) skew,
- Describe improved procedures for defining confidence limits.

Within the last year, the HFAWG has developed an approach for evaluating and comparing the EMA approach to Bulletin 17B methods through the use of split sampling techniques and Monte Carlo simulations. The split sampling techniques will be applied to data from about 80 gaging stations whose record length is in the range of 75 to 100 years. The Monte Carlo simulations will include the Pearson Type III distribution, other alternative frequency distributions and mixtures of distributions to test the robustness of the EMA and Bulletin 17B methods. The USGS and BOR are adding the latest EMA procedures to flood frequency programs used by their agencies and these programs will be used for the testing noted above. It is anticipated that the EMA – Bulletin 17B testing will begin this summer (2007).

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